Missouri Department of Natural Resources
Water Protection Program

Total Maximum Daily Load (TMDL)

for

Indian Camp Creek
Warren and St. Charles Counties
Missouri

Completed: December 21, 2009
Approved: February 25, 2010

Total Maximum Daily Load (TMDL) for Indian Camp Creek
Pollutant: Inorganic sediment


State map showing location of watershed

Name: Indian Camp Creek

Location: Warren and St. Charles Counties, Missouri

Nearby Cities: Wright City and Foristell

Hydrologic Unit Code (HUC): 07110008-0407

Water Body Identification (WBID): 212

Missouri Stream Class: Class C stream[1]

Designated beneficial uses[2]:
- Livestock and wildlife watering
- Protection of warm-water aquatic life
- Protection of human health (fish consumption)
- Whole body contact recreation - Category B

Use that is Impaired:
- Protection of warm-water aquatic life

Length and Legal Descriptions of Impaired Segments:
Length of Impaired Segment: 5 miles
Length of Impairment within Segment: 0.3 miles
Location of Impaired Segment: Section 6, T47N R01E to Section 4, T47N, R01W
Location of Impairment within Segment: Section 10, T47N, R01W

Pollutant: Inorganic sediment

Listed Pollutant Source: JZ Landfill

TMDL Priority Ranking: High

[1] Class C streams may cease flow in dry periods, but maintain permanent pools that support aquatic life. See 10 CSR 20-7.031(1)(F)6.
[2] For designated beneficial uses see 10 CSR 20-7.031(1)(C) and Table H.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Introduction

This Indian Camp Creek Total Maximum Daily Load, or TMDL, for inorganic sediment is being established in accordance with Section 303(d) of the federal Clean Water Act. This water quality limited segment in Warren County is included on the U.S. Environmental Protection Agency approved Missouri 2008 303(d) list of impaired waters.

The purpose of a TMDL is to determine the pollutant loading a water body can assimilate without exceeding Missouri's water quality standards. Missouri's water quality standards consist of three components: designated beneficial uses, water quality criteria to protect those uses and an antidegradation policy. The TMDL establishes the pollutant load allocation necessary to meet the water quality standards established for each water body based on the relationship between pollutant sources and instream water quality conditions. A TMDL consists of a wasteload allocation, a load allocation and a margin of safety. The wasteload allocation is the fraction of the total pollutant load apportioned to point sources. The load allocation is the fraction of the total pollutant load apportioned to nonpoint sources. The margin of safety is a percentage of the TMDL that accounts for any uncertainty associated with the model assumptions as well as any data inadequacies.

The current inorganic sediment pollutant for Indian Camp Creek first appeared on Missouri's 2004/2006 303(d) List of impaired waters and replaced previous 303(d) listings of nonvolatile suspended solids for the impaired segment. Since nonvolatile suspended solids and inorganic sediment have essentially the same meaning, the listing was changed to inorganic sediment to better characterize the impairment. The two terms may be used interchangably and the data used to identify the listed impairment has not changed. Another change from listings prior to the 2004/2006 303(d) List is the removal of ammonia as a pollutant of concern. Recent monitoring of Indian Camp Creek has found the stream to be meeting Missouri's water quality criteria for ammonia and the stream is no longer considered to be impaired for ammonia. A final modification of the listing initiated with the 2004/2006 303(d) List is a change by the EPA to list the entire classified segment length of five miles as impaired instead of previous listings of 0.3 miles.

Much of the format of this TMDL was developed by EPA in 2006 to meet the requirements of the 2001 Consent Decree, *American Canoe Association, and et al. v. EPA*[3]. However, at that time there were no data from Indian Camp Creek to complete the load duration curve (Figure 2). Therefore, the Missouri Department of Natural Resources collected the necessary water quality data in early 2009 and has completed the TMDL following the EPA methodology and using the graphs, flow and TMDL curve as calculated by EPA.

1.1 Geography and Land Use

Indian Camp Creek is located in the Cuivre River Basin within Warren and St. Charles counties, Missouri. The watershed associated with the impaired segment is approximately 27.52 square miles. Within the watershed, forest and woodland is the predominant land use type accounting for more than 45 percent of the watershed cover. Grassland and cropland land uses make up the next abundant land use types with each accounting for approximately 22 percent of the Indian Camp Creek watershed. Urban areas account for only 2 square miles of the watershed, and are 7.4 percent of the total watershed area. See Table 1 and Figure 1 for additional land use data and information.

[3] No. 98-1195-CV-W in consolidation with No. 98-4282-CV-W, February 27, 2001.

Figure 1. Landuse Map of the Indian Camp Creek Watershed (MoRAP 2005)

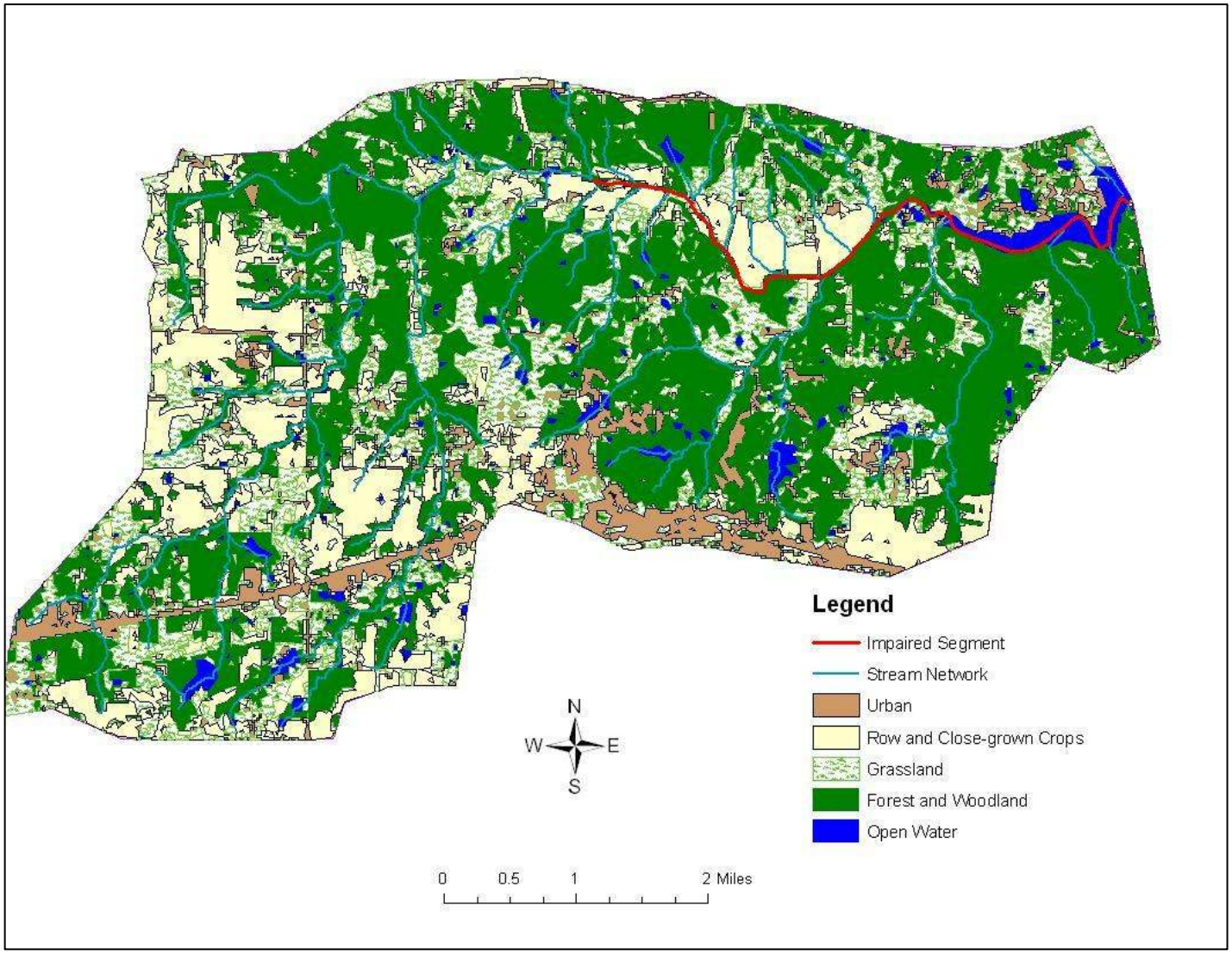


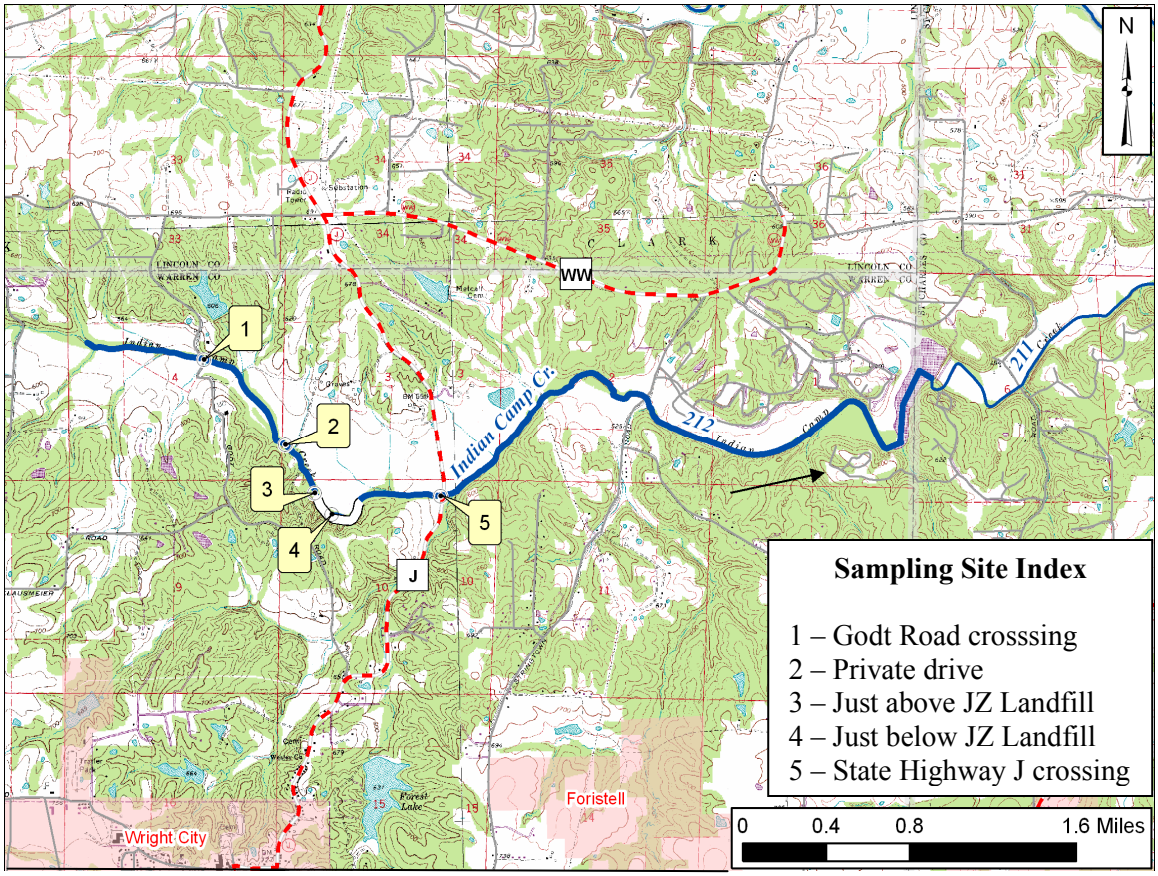
Table 1. Land Use Distribution for the Impaired Indian Camp Creek Watershed

Land Use Types	Acres	Square Miles	Percentage
Urban	1,306	2.0	7.3 %
Row and Close-grown Crops	3,847	6.0	21.8 %
Grassland	3,906	6.1	22.2 %
Forest and Woodland	7,987	12.5	45.4 %
Open Water	568	0.9	3.3 %
TOTAL:	17,614	27.5	100.0%

1.2 Defining the Problem

Indian Camp Creek is on the 2008 303(d) List as being impaired by inorganic sediment. A length of 0.3 miles downstream of the JZ Landfill site is considered impaired as listed in the 1998 and 2002 303(d) Lists (Figure 2). The entire length of the classified segment is 5 miles. Inorganic sediment is composed of mineral particles such as clay, silt, sand, assorted-sized rocks and other non-organic materials. These particles enter the stream via erosion of soils or other materials within the watershed. Indian Camp Creek was placed on the Missouri 303(d) List of impaired waters for inorganic sediment primarily based on the department's observations of violations of general criteria. Observations made in the 1990s of sediments being deposited into the creek, as well as general fisheries data, and the effects of sediment on fish were the initial data used to consider Indian Camp Creek for 303(d) listing. Since the initial 303(d) listing, the department has developed a protocol to determine if sediment is actually the pollutant of concern for listed streams. The first step of this protocol is a biological assessment to determine if the stream's biological community is showing signs of impairment. However, a biological assessment for Indian Camp Creek has not yet been completed. For this TMDL, sediment targets were derived using generalized information from the ecological drainage unit in which Indian Camp Creek is contained. In this case, the Central Plain-Cuivre-Salt ecological drainage unit was used. No quantitative sediment data exist for Indian Camp Creek.

Figure 2. Topographic Map Showing Indian Camp Creek Water Quality Sampling Sites



2. Source Inventory and Assessment

Source assessment characterizes known, suspected and potential sources of pollutant loading to the impaired water body. Pollutant sources identified within the watershed are categorized and quantified to the extent that information is available. Sources of inorganic sediment may be point (regulated) or nonpoint (unregulated) in nature.

2.1 Point Sources

Thirty facilities in the Indian Camp Creek watershed have permits through the Missouri State Operating Permit program [4] (Table 2). This program issues permits to build, erect, alter, replace, operate, use or maintain existing point sources of water pollution. Permits available through this program can be site specific, general, or for storm water. Site specific permits are issued to reflect the unique nature of the wastewater or the receiving stream, and are designated with permit numbers beginning "MO-". General and storm water permits are issued based on the type of activity occurring and are meant to be flexible enough to allow for ease and speed of issuance, while providing the required protection of water quality. General and storm water permits are issued to activities similar enough to be covered by a single set of requirements, and are designated with permit numbers beginning with "MOG-" or "MOR-" respectively.

Twelve of the permits within the watershed are site specific, six are general permits, and 12 are storm water permits. Of the 18 site specific and general permits, only the MFA Bulk Plant, Incline Village Lake, and Masterson & Associates North do not have permit effluent limits for total suspended solids. Total suspended solids concentration is a potential quantitative indicator of sediment; therefore, those facilities lacking effluent limits for total suspended solids are not likely to contribute to the inorganic sediment load in Indian Camp Creek. Observations made by department staff in the 1990s have identified the JZ Landfill site[5] (MO-0108103) as the primary point source contributor of inorganic sediment to Indian Camp Creek. Likewise, a 2005 department inspection report also documents erosion concerns at the JZ Landfill area and notes the presence of a gully (MoDNR 2005).

Table 2: Permitted Facilities in the Indian Camp Creek Watershed

Facility	Permit number	County	Design Flow (MGD*)
MODOT, I-70 Rest Area	MO-0087190	Warren	0.0230
MAWC† – Warren/Lincoln #1	MO-0098817	Warren	0.0800
MAWC – Warren/Lincoln #2	MO-0100358	Warren	0.0800
JZ Disposal Demo Landfill	MO-0108103	Warren	0.0010
Orchard Farm Parc	MO-0109495	Warren	0.0110
North Oak Sewer District	MO-0109673	Warren	0.0500
Pleasant Oak Mobile Home	MO-0110680	Warren	0.0195
Shannon's Little River Farm	MO-0113042	Warren	0.0030
Country Horizon MHP‡	MO-0113387	Warren	0.0030
Gables Apartments	MO-0113786	Warren	0.0030
Midway Village MHP	MO-0117269	Warren	0.0187
Faith Christian Fellowship	MO-0129721	Warren	0.0055
MFA Bulk Plant-Wright City	MOG-350142	Warren	0.0000

[4] The Missouri State Operating Permit Program is Missouri's program for administering the federal National Pollutant Discharge Elimination System program

[5] The JZ Landfill site includes three landfills and is currently inactive.

Lafarge North America	MOG-490906	Warren	0.0000
Schreiter Concrete	MOG-490648	Warren	0.0000
Incline Village Lake	MOG-690021	Warren	0.0000
Masterson & Assoc North	MOG-821041	Warren	0.0000
Wright City Meat Company	MOG-822167	Warren	0.0000
North Oak Estates STF§	MOR-103880	Warren	Storm water
Vacant Land Development	MOR-104988	Warren	Storm water
Autumn Ridge	MOR-107735	Warren	Storm water
Providence Estates-Phase 9	MOR-108300	Warren	Storm water
Falcons Crest	MOR-108661	Warren	Storm water
Gettysburg Commons	MOR-109E48	Warren	Storm water
Hickory Trails	MOR-109V20	Warren	Storm water
I-70 West Industrial Park	MOR-10A767	Warren	Storm water
Hickory Hollow	MOR-10A870	St Charles	Storm water
Steve Herr Subdivision	MOR-10B007	Lincoln	Storm water
Progress Parkway	MOR-10B138	Warren	Storm water
Warrenton Athletic Complex	MOR-10C388	Warren	Storm water

* MGD = million gallons per day † MAWC = Missouri American Water Company
‡ MHP = mobile home park § STF = sewage treatment facility

2.2 Nonpoint Sources

Another potential source of the sediment impairment to Indian Camp Creek is runoff from agricultural nonpoint sources. In addition to point source contributions, cropland adjacent to and draining into Indian Camp Creek could also be contributing to the stream's inorganic sediment impairment. Anywhere land is exposed, soil will erode into the stream and increase turbidity and inorganic sediment concentrations. Likewise, although there are no state-permitted concentrated animal feeding operations, or CAFOs, in the watershed, the presence of lower density livestock populations could also be contributing to the sediment load in Indian Camp Creek (Table 3). Livestock tend to concentrate near feeding and watering areas causing those areas to become barren of plant cover, thereby increasing the possibility of erosion during a storm event (Sutton, 1990). For these reasons, overland runoff during rain events can easily carry sediment from both feed lots and cropland to the stream. A certain amount of sediment enters the stream naturally due to normal fluvial processes, accounting for the natural background level of inorganic sediments. However, human impacts on the land have greatly increased erosion of sediment into streams, making sediment the number one pollutant in the country.

Table 3. Livestock Estimates for Warren County

Livestock and Poultry	Animal Units
Cattle	
Beef	(D)
Milk	(D)
Cow/Calf	17,243
Hogs/Pigs	21,761
Sheep/Lambs	445
Poultry	
Layers	1,308
Broilers	(D)
Turkeys	11
Horses/Ponies	1,020

(D) = Withheld to avoid disclosing data for individual farms. (NASS USDA, 2009)

3. Applicable Water Quality Standards and Water Quality Targets

The purpose of developing a TMDL is to identify the pollutant loading that a water body can assimilate and still achieve water quality standards. Water quality standards are therefore central to the TMDL development process. Under the federal Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters (U.S. Code Title 33, Chapter 26, Subchapter III (U.S. Code, 2009)). Water quality standards consist of three components: designated beneficial uses, water quality criteria to protect those uses, and an antidegradation policy.

3.1 Designated Beneficial Uses

- Livestock and wildlife watering.
- Protection of warm-water aquatic life.
- Protection of human health (fish consumption).
- Whole body contact recreation - Category B.

3.2 Impaired Use:

- Protection of warm-water aquatic life.

3.3 Antidegradation Policy

Missouri's water quality standards include the EPA "three-tiered" approach to antidegradation, and may be found at 10 CSR 20-7.031(2).

Tier 1 – Protects existing uses and a level of water quality necessary to maintain and protect those uses. Tier I provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after Nov. 28, 1975, the date of EPA's first Water Quality Standards Regulation.

Tier 2 – Protects and maintains the existing level of water quality where it is better than applicable water quality criteria. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economical or social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national and state resource waters, such as waters of national and state parks, wildlife refuges and waters of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality.

Waters in which a pollutant is at, near, or exceeds the water quality criteria are considered in Tier 1 status for that pollutant. Therefore, the antidegradation goal for Indian Camp Creek is to restore the stream's inorganic sediment level to the water quality standards.

3.4 General Criteria

The impairment of Indian Camp Creek is based on exceedances of the general criteria contained in Missouri's Water Quality Standards, 10 CSR 20-7.031(3)(A), (C) and (G), which state:

(A) Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.

(C) Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor, or prevent full maintenance of beneficial uses.

(G) Waters shall be free from physical, chemical, or hydrologic changes that would impair the natural biological community.

When water quality criteria are expressed as a narrative, a measurable indicator of a pollutant may be selected to express the narrative as a numeric value. There are many quantitative indicators of sediment, such as total suspended solids, turbidity, and bedload sediment, which are appropriate to describe sediment in rivers and streams (U.S. EPA, 2006b). A concentration of total suspended solids was selected to represent the numeric target for this TMDL because it enables the use of the highest quality available data and is included in permit requirements and monitoring data.

4. Calculation of Load Capacity and Allocations

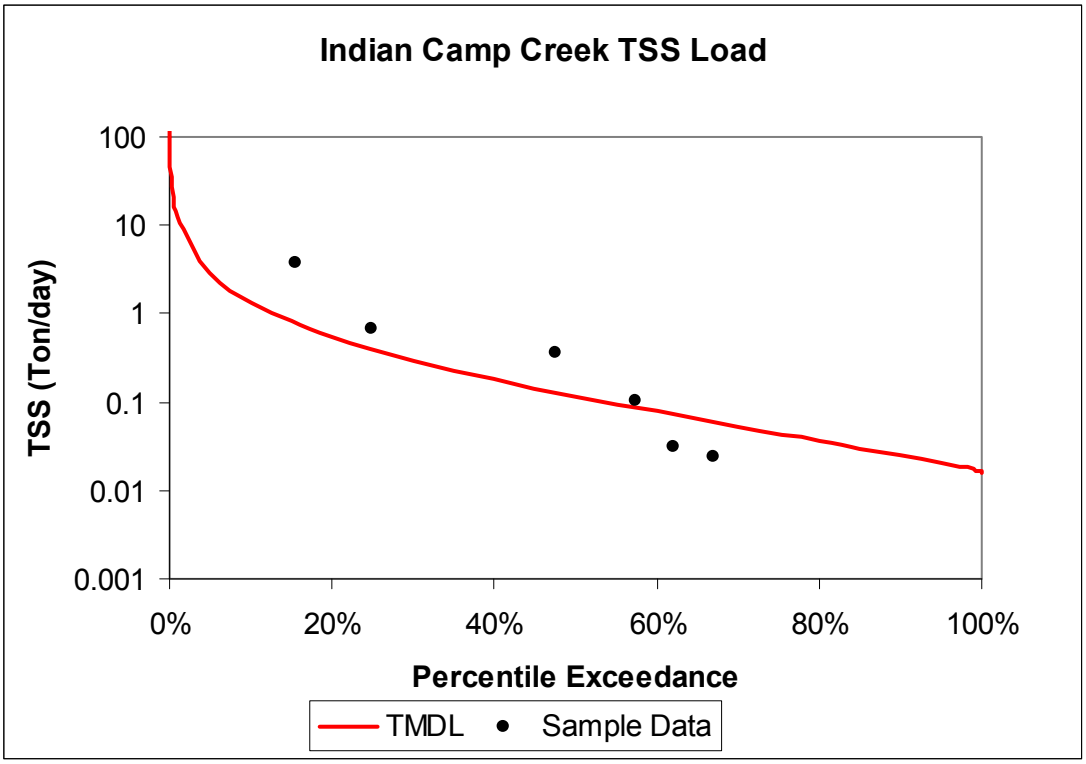
Load capacity is defined as the maximum pollutant load that a water body can assimilate and still attain water quality standards. It is equal to the sum of the wasteload allocation, the load allocation, and a margin of safety, and can be expressed as an equation:

$$LC = \sum WLA + \sum LA + MOS$$

Where LC is the loading capacity, $\sum$WLA is the sum of the wasteload allocations, $\sum$LA is the sum of the load allocations, and MOS is the margin of safety. The load capacity for this TMDL has been defined as a load duration curve over the range of flows for Indian Camp Creek where the target total suspended solids load is the TMDL (Figure 3). In Figure 3, the curve is the TMDL, the points are total suspended solids loads calculated from concentrations in Indian Camp Creek.

The average daily flow at the outlet of the Indian Camp Creek watershed was synthesized from flow data from the U.S. Geological Survey gaging station on the Cuivre River near Troy (USGS-05514500). Both the Indian Camp Creek watershed and the Cuivre River watershed exist in the same larger watershed, are of similar geology and topography, and their outlets are only about seven miles apart. For these reasons, it is assumed that no significant climatic variation, especially precipitation, exists between the two watersheds. The area of the Cuivre River watershed draining to USGS-05514500 covers 903 square miles. The entire Indian Camp Creek watershed, including the impaired portion, covers 31 square miles, giving it an area ratio with the Cuivre River watershed of 31:903 or 0.034. Only data from within the time frame used to develop the flow duration curve were included in the analysis. Flow data used was from the period Oct. 3, 1989 to Sept. 2, 2009.

Figure 3. TMDL Load Duration Curve for Total Suspended Solids (TSS)



4.1 Modeling Approach

When narrative criteria are targeted for an impaired segment, a reference approach is used. Currently, Missouri does not have a numeric criterion for inorganic sediment. Because a measurement of total suspended solids concentration is the sum of all organic and inorganic suspended solids, inorganic sediment concentration in the water column is at most equal to that of total suspended solids. Assuming the ratio of inorganic sediment to total suspended solids is constant for a particular watershed and during a specific event, any reduction in one would parallel that of the other. Consequently, total suspended solids concentration may be used as the target for the inorganic sediment impairment. For a full description of the development of suspended sediment targets using reference load duration curves refer to Appendix C. In this approach, the target for pollutant loading is the 25th percentile of the current ecological drainage unit condition calculated from all data available within the ecological drainage unit in which the water body is located. Therefore, the 25th percentile is targeted as the TMDL load duration curve. In the case of Indian Camp Creek, data from the Central Plains-Cuivre-Salt ecological drainage unit was used.

4.2 Wasteload Allocation (Point Source Load)

The wasteload allocation portion of a TMDL is the maximum allowable amount of a pollutant that can be assigned to point sources. The wasteload allocation is set to the lesser of current permit limits or technology based effluent limits. Technology based effluent limits are defined in a permit based on facility type. Secondary treatment permit limits for total suspended solids are a weekly average concentration of 45 mg/L and a monthly average concentration of 30 mg/L (or 45/30). Equivalent to secondary treatment permit limits for total suspended solids are a weekly average concentration of 60 mg/L and a monthly average concentration of 45 mg/L. Wastewater treatment lagoon permit limits for total suspended solids are 120 mg/L average weekly and 80 mg/L average monthly, respectively. Additionally, permits can be written to target lower limits if the specific facility is capable of performance exceeding technology based effluent limits.

There are no municipal wastewater treatment facilities within the Indian Camp Creek watershed. However, there are 11 domestic wastewater treatment facilities that discharge either directly to Indian Camp Creek or to one of its tributaries. Table 4 lists these permitted site specific point source discharges and wasteload allocations based on their current permit limits and permitted design flows. Based on the assessment of sources, point sources discharging domestic wastewater do not significantly contribute to the water quality impairment relative to inorganic sediment impacts on stream biology. Therefore, no net reduction in current permit limits is required for domestic waste water treatment facilities within the watershed and wasteload allocations for these facilities are set at current permit limits and conditions.

The JZ Landfill facility (MO-0108103) discharges to the impaired segment of Indian Camp Creek and has been identified by the department as the most significant source of inorganic sediment loading to the stream. According to discharge monitoring reports, the facility discharges in response to storm events and is not anticipated to discharge during critical low-flow conditions (95 percent flow exceedance). However, during and immediately following storm events the facility has reasonable potential to cause or contribute to the inorganic sediment impairment in Indian Camp Creek. The amount and extent of impact on Indian Camp Creek depends on the volume of sediment discharged, instream assimilative capacity and any settling that may occur onsite or downstream of the facility. At the permitted facility design flow and total suspended solids maximum daily limit, the total suspended solids wasteload allocation for the facility is 0.0003 tons/day.

During critical low-flow conditions, it is reasonable to allocate the entire loading capacity of total suspended solids as wasteload allocations due to the lack of pollutant contributions from precipitation induced surface water runoff. The loading capacity for total suspended solids during critical low-flow conditions (95 percent flow exceedance) can therefore be allocated among point sources within the Indian Camp Creek watershed, less a margin of safety to account for uncertainty. A wasteload allocation of 0.0189 tons/day, derived from the loading capacity of 0.021 tons/day subtracted by a 10 percent margin of safety, will ensure permitted facilities will not cause or contribute to the inorganic sediment impairment of Indian Camp Creek during critical low-flow conditions.

All other listed facilities within the watershed have general or storm water permits (see Table 2). The department assumes activities in the watershed will be conducted in compliance with Missouri's general and storm water permits including monitoring and discharge limitations. Compliance with these permits should result in sediment loading at or below applicable targets. For these reasons, the wasteload allocations are set at present loads and listings of permit-specific best management practices. However, the wasteload allocations listed in this TMDL do not preclude the establishment of future point sources of sediment loading in the watershed. Any future point sources should be evaluated in light of the TMDL established and the range of flows into which any additional load will impact.

Table 4. Site Specific Permit Wasteload Allocations in the Indian Camp Creek Watershed

Facility Name	Permit Number	Facility Type	Wasteload allocation (tons per day) d / w / m*
MODOT, I-70 Rest Area	MO-0087190	Rest area	NA / 0.0044 / 0.0029
MAWC – Warren/Lincoln #1	MO-0098817	Public subdivision	NA / 0.0100 / 0.0067
MAWC – Warren/Lincoln #2	MO-0100358	Public subdivision	NA / 0.0100 / 0.0067
J Z Landfill	MO-0108103	Landfill	0.0003 / NA / 0.0002
Orchard Farm Park	MO-0109495	Mobile home park	NA / 0.0022 / 0.0015

North Oak Sewer District	MO-0109673	Public subdivision	NA / 0.0094 / 0.0063
Pleasant Oak Mobile Home	MO-0110680	Mobile home park	NA / 0.0037 / 0.0024
Shannon's Little River Farm	MO-0113042	Public subdivision	NA / 0.0014 / 0.0008
Country Horizon MHP	MO-0113387	Mobile home park	NA / 0.0006 / 0.0004
Gables Apartments	MO-0113786	Public subdivision	NA / 0.0018 / 0.0011
Midway Village MHP	MO-0117269	Mobile home park	NA / 0.0094 / 0.0063
Faith Christian Fellowship	MO-0129721	Church	NA / 0.0010 / 0.0007

*Permit limits based on current design loads where d=daily, w=weekly, m=monthly average.

Wasteload allocations = (design flow in cfs) * (total suspended solids concentration in mg/L) * (conversion factor of 0.0026975) = tons/day

4.3. Load Allocation (Nonpoint Source Load)

The load allocation portion of a TMDL is the amount of a pollutant assigned to nonpoint sources. The TMDL curve is set as an estimate of expected reference conditions over a range of flows. The load allocation for Indian Camp Creek is set at the remainder for the TMDL loading curve after removing allowances for the point source wasteload allocation and the margin of safety (10 percent of the TMDL). For example, at the 50th percentile of flow (median flow) the load capacity is 0.117 tons per day (Table 5). Therefore, the margin of safety is 0.0117 tons per day and the load allocation is 0.0864 tons per day once the wasteload allocation loading is removed.

Table 5. Total Suspended Solids Allocations for the Indian Camp Creek Watershed

Percentile Flow Exceedance	Flow (cfs)	TMDL (ton/day)	MOS (ton/day)	LA (ton/day)	WLA (ton/day)
95%	0.59	0.021	0.0021	0	0.0189
90%	0.71	0.025	0.0025	0.0036	0.0189
70%	1.51	0.053	0.0053	0.0288	0.0189
50%	3.34	0.117	0.0117	0.0864	0.0189
30%	8.55	0.300	0.0300	0.2511	0.0189
10%	38.38	1.346	0.1346	1.1925	0.0189
5%	81.83	2.870	0.2870	2.5641	0.0189

cfs = cubic feet per second, MOS = margin of safety (10 percent),
LA = load allocation, WLA = wasteload allocation

4.4 Margin of Safety

A margin of safety is required in the TMDL calculation to account for uncertainties in scientific and technical understanding of water quality in natural systems. The margin of safety is intended to account for such uncertainties in a conservative manner. Based on EPA guidance, the margin of safety can be achieved through one of two approaches:

(1) Explicit – Reserve a numeric portion of the load capacity as a separate term in the TMDL.

(2) Implicit – Incorporate the margin of safety as part of the critical conditions for the wasteload allocation and the load allocation calculations by making conservative assumptions in the analysis.

An explicit 10 percent margin of safety has been applied to the Indian Camp Creek TMDL and is reflected in the allocations presented in Table 5.

5. Seasonal Variation

The impairment of Indian Camp Creek is due to inorganic sediments being carried into the water body through storm water runoff. These conditions are more likely to occur during seasonal periods having significant precipitation. The TMDL load duration curve, however, represents flow under all possible stream conditions. The advantage of a load duration curve approach is that it avoids the constraints associated with using a single-flow critical condition during the development of the TMDL. Because the TMDL is applicable under all flow conditions, it is also applicable for all seasons. Seasonal variation is therefore implicitly taken into account within the TMDL calculations.

6. Implementation

The water quality impairment for Indian Camp Creek is inorganic sediment from the JZ Landfill as well as inputs from agricultural nonpoint sources. Therefore, any practices used to implement this TMDL will focus on these sources.

6.1 Point Sources

This part of the TMDL will be implemented through permit action. Effluent limits and monitoring requirements for the JZ Landfill operating permit will be reevaluated to reflect the water quality targets set by the TMDL as the permit approaches renewal. This includes effluent limits for total suspended solids using the wasteload allocation developed for this TMDL and instream monitoring of total suspended solids or turbidity. Future inspections of the JZ Landfill by the department will determine the extent and nature of erosion at the site. Discharge permits may need to be amended to include additional measures (e.g., a storm water pollution prevention plan) that ensure the facility does not continue to cause or contribute to the impairment of Indian Camp Creek. The department will also investigate additional options available for controlling erosion at the JZ Landfill site, which may include, but are not limited to, use of funds from a forfeited financial assurance instrument for landfill post closure activities.

Additionally, any other permitted facilities identified to contribute to the sediment loading of the impaired segment shall adopt appropriate best management practices to reduce such loading from their storm water outfalls. Best management practices are recommended methods, structures, and practices designed to prevent or reduce water pollution. These facilities must also regularly measure instream pollutant concentrations to determine the efficacy of the control measures.

6.2 Nonpoint Sources

Nonpoint sources of inorganic sediment are not regulated in Missouri. However, with cropland and grassland accounting for approximately 44 percent of the land area in the watershed, agricultural runoff is likely a major component of nonpoint source contributions to the impaired segment. Contributions of inorganic sediment from agricultural areas should be reduced to meet the TMDL targets. To reduce the loading and effect of inorganic sediment on Indian Camp Creek, efforts should be made to encourage agricultural producers in the watershed to adopt erosion control best management practices. The concept of best management practices is one of a voluntary and site-

specific approach to water quality problems. In the Indian Camp Creek watershed, agricultural best management practices should focus on erosion control measures such as grassy swales, contour farming, the expansion or enhancement of riparian zones, off-stream watering of livestock, and rotational grazing practices.

In an effort to most effectively implement erosion control best management practices, the department may work with the Natural Resources Conservation Service and the local Soil and Water Conservation District to encourage area land owners to implement these practices. An additional approach may be to work with these agencies to form a watershed group comprised of local stakeholders to promote the use of erosion control practices.

7. Monitoring

Currently, a plan has not been formalized for monitoring inorganic sediment in Indian Camp Creek. Post-TMDL monitoring is usually scheduled and carried out by the Department approximately three years after the approval of the TMDL or in a reasonable time period following completion of permit compliance schedules and the application of new effluent limits. Additionally, any available volunteer water quality monitoring or permittee instream monitoring that occurs on Indian Camp Creek will be used for screening purposes to compare the stream's current condition with future, post-TMDL conditions. The Department will also routinely examine physical habitat, water quality, invertebrate community, and fish community data collected by the Missouri Department of Conservation under its Resource Assessment and Monitoring Program. This program randomly samples streams across Missouri on a five to six year rotating schedule.

8. Reasonable Assurances

The department has the authority to issue and enforce Missouri State Operating Permits. Inclusion of effluent limits derived from TMDL wasteload allocations into a state permit, and at least quarterly monitoring of the effluent reported to the department, should result in compliance with water quality standards. In most cases, Reasonable Assurance, in reference to TMDLs, relates only to point sources. As a result, any assurances that nonpoint source contributors of inorganic sediment will implement measures to reduce their contribution in the future will not be found in this section. Instead, discussion of inorganic sediment reduction efforts relating to nonpoint sources can be found in Section 6.2 of this document.

9. Public Participation

EPA regulations require that TMDLs be subject to public review (40 CFR 130.7). This water quality limited segment of Indian Camp Creek in Warren County is included on the EPA approved Missouri 2008 303(d) list of impaired waters. The public notice period was from Nov. 12, 2009 to Dec. 12, 2009. During this period, two public comments were received and addressed, however no changes to the TMDL were necessary. Groups that received the public notice announcement include the Missouri Clean Water Commission, the Missouri Water Quality Coordinating Committee, the Missouri Department of Conservation, the Warren and St. Charles County Soil and Water Conservation Districts, the Warren and St. Charles County Commissions, 42 Stream Team volunteers in the

watershed, the five state legislators representing Warren and St. Charles Counties and any affected facilities. Also, the department posted the notice, the sediment TMDL information sheet and this TMDL document on the department Web site, making them available to anyone with access to the Internet. Announcement of the public notice period for this TMDL was also issued as a press release to local media outlets in the proximity of the Indian Camp Creek watershed. Any comments received and the department's responses to those comments will be maintained in the department's Indian Camp Creek TMDL file.

10. Administrative Record and Supporting Documentation

An administrative record on the Indian Camp Creek TMDL has been assembled and is being kept on file with the Missouri Department of Natural Resources. It includes any studies, data and calculations the on which the TMDL is based.

11. Appendices

Appendix A – Data collected from Indian Camp Creek used to populate the TMDL curve
Appendix B – USGS gage sites used for developing total suspended solid target
Appendix C – Development of suspended sediment targets using reference load duration curves

References

KDHE, Kansas Department of Health and Environment. 2000. Upper Wakarusa River TMDL (Sediment Impact on Aquatic Life) [Online WWW]. Available URL: http://www.kdheks.gov/tmdl/klr/UpWakaTSS.pdf and Little Arkansas River TMDL (Sediment Impact on Aquatic Life) [Online WWW]. Available URL: http://www.kdheks.gov/tmdl/la/LittleArkSed.pdf [Accessed 28 April 2009].

NASS USDA, National Agricultural Statistics Service, U.S. Department of Agriculture. 2009. 2007 Census of Agriculture: Missouri County Level Data [Online WWW]. Available URL:http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Missouri/mov1.pdf [Accessed 27 April 2009].

MoDNR, Missouri Department of Natural Resources. 2005. Memo: Inspection at J.Z. Disposal, Inc. DLF by Paul E. Mueller. June 2, 2005.

MoDNR, Missouri Department of Natural Resources. 2007. Quality Assurance Project Plan for Wasteload Allocations/Special Studies

MoRAP, Missouri Resource Assessment Partnership. 2005. Land Use/Land Cover Data [computer file]. [Online WWW]. Available URL: http://msdis.missouri.edu/

Sutton, Alan L. 1990. Animal Agriculture's Effect on Water Quality Pastures and Feedlots. WQ-7. Purdue University Extension. [Online WWW]. Available URL: http://www.ces.purdue.edu/extmedia/wq/wq-7.html [Accessed 02 Sept. 2009]

U.S. EPA. 2006a. Development of Suspended Sediment Targets using Reference Load Duration Curves, EPA Region 7, Kansas City,

U.S. EPA. 2006b. Framework for Developing Suspended and Bedded Sediments (SABS) Water Quality Criteria. EPA-822-R-06-001, May 2006.

Appendix A

Indian Camp Creek data used to populate the TMDL curve

Site Name	Year	Mo	Day	Time	Flow	C	DO	pH	SC	TSS	TSS Method
At State Highway J crossing	2008	12	10	08:55	1.5	1.4	11.5	7.7	708	2.499	SM2540-D
At State Highway J crossing	2009	1	9	08:40	2.0	0.4	12.5	7.9	592	2.499	SM2540-D
At State Highway J crossing	2009	2	12	08:35	25.6	3.9	12.2		272	29	SM2540-D
At State Highway J crossing	2009	2	26	08:05	2.5	6.9	10.5	8.0	540	7	SM2540-D
At State Highway J crossing	2009	3	12	09:10	4.0	3.3	12.2	8.8	500	16	SM2540-D
At State Highway J crossing	2009	5	1	08:15	12.7	16.1	8.4	7.9	358	10	SM2540-D

Note: Flow in cubic feet per second; C=temperature in degrees Celsius; DO=Dissolved Oxygen in mg/L; SC=Specific Conductivity in microsiemens per centimeter; TRB=turbidity in Nephelometric turbidity units; TSS = total suspended solids

Appendix B

USGS gage sites used for developing the ecological drainage unit total suspended solid target

USGS no.	Site Location
05495000	Fox River at Wayland, Mo.
05496000	Wyaconda River above Canton, Mo.
05497150	North Fabius River near Ewing, Mo.
05500000	South Fabius River near Taylor, Mo.
05499900	Troublesome Creek near Ewing, Mo.
05508000	Salt River near New London, Mo.
05514500	Cuivre River near Troy, Mo.

Appendix C

Development of suspended sediment targets using reference load duration curves

Overview

This procedure is used when a lotic[6] system is placed on the 303(d) List for a pollutant and the designated use being addressed is aquatic life. In cases where pollutant data for the impaired stream is not available a reference approach is used. The target for pollutant loading is the 25th percentile calculated from all data available within the ecological drainage unit (EDU) in which the water body is located. Additionally, it is also unlikely that a flow record for the impaired stream is available. If this is the case, a synthetic flow record is needed. In order to develop a synthetic flow record calculate an average of the log discharge per square mile of USGS gaged rivers for which the drainage area is entirely contained within the EDU. From this synthetic record develop a flow duration from which to build a load duration curve for the pollutant within the EDU. However in the case of this Indian Camp Creek TMDL, a straight percentage of the flow measured at the USGS gage Cuivre River near Troy (USGS 05514500) was used. The flow developed was amended by adding the sum of the permitted facilities in the watershed.

From this population of load durations follow the reference method used in setting nutrient targets in lakes and reservoirs. In this methodology the average concentration of either the 75th percentile of reference lakes or the 25th percentile of all lakes in the region is targeted in the TMDL. For most cases available pollutant data for reference streams is also not likely to be available. Therefore follow the alternative method and target the 25th percentile of load duration of the available data within the EDU as the TMDL load duration curve. During periods of low flow the actual pollutant concentration may be more important than load. To account for this during periods of low flow the load duration curve uses the 25th percentile of EDU concentration at flows where surface runoff is less than 1 percent of the stream flow. This result in an inflection point in the curve below which the TMDL is calculated using load calculated with this reference concentration.

Methodology

The first step in this procedure is to locate available pollutant data within the EDU of interest. These data along with the instantaneous flow measurement taken at the time of sample collection for the specific date are recorded to create the population from which to develop the load duration. Both the date and pollutant concentration are needed in order to match the measured data to the synthetic EDU flow record.

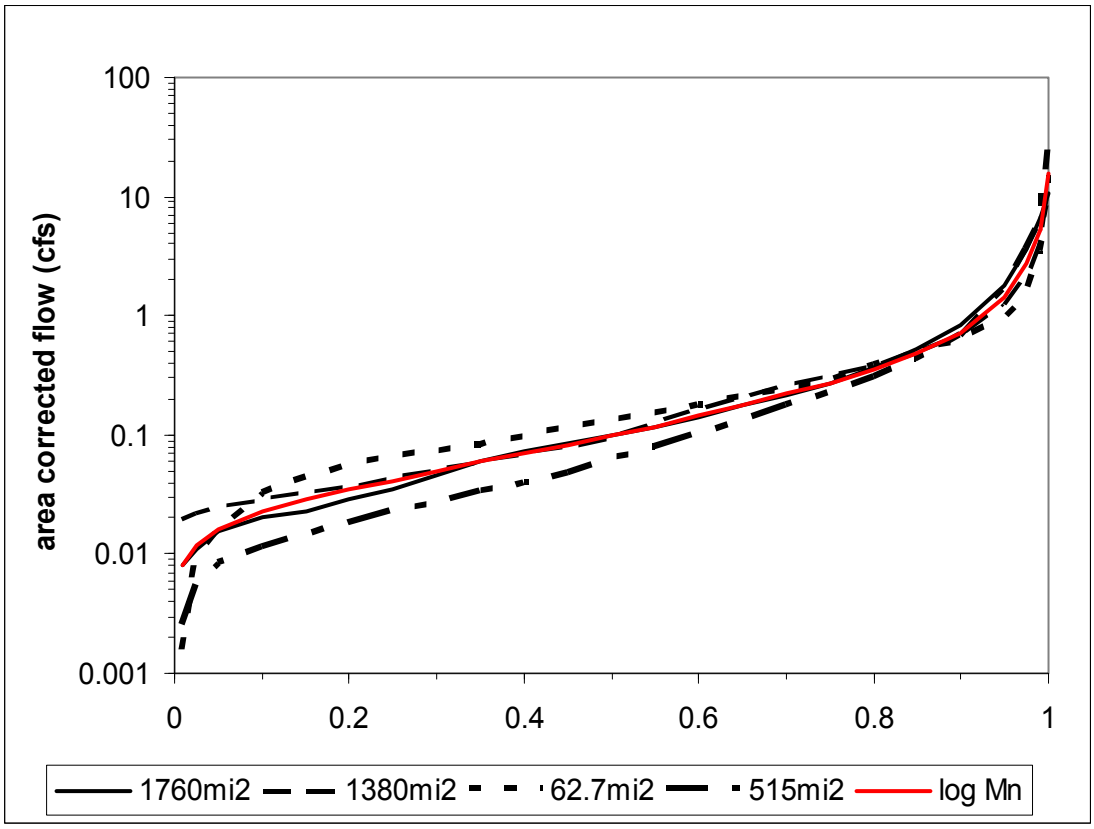
Secondly, collect average daily flow data for gages with a variety of drainage areas for a period of time to cover the pollutant record. From these flow records normalize the flow to a per square mile basis. Average the log transformations of the average daily discharge for each day in the period of record. For each gage record used to build this synthetic flow record calculate the Nash-Sutcliffe statistic to determine if the relationship is valid for each record. This relationship must be valid in order to use this methodology. This new synthetic record of flow per square mile is used to develop the load

[6] Lotic = pertaining to moving water

duration for the EDU. The flow record should be of sufficient length to be able to calculate percentiles of flow.

The following examples show the application of the approach to one Missouri EDU.

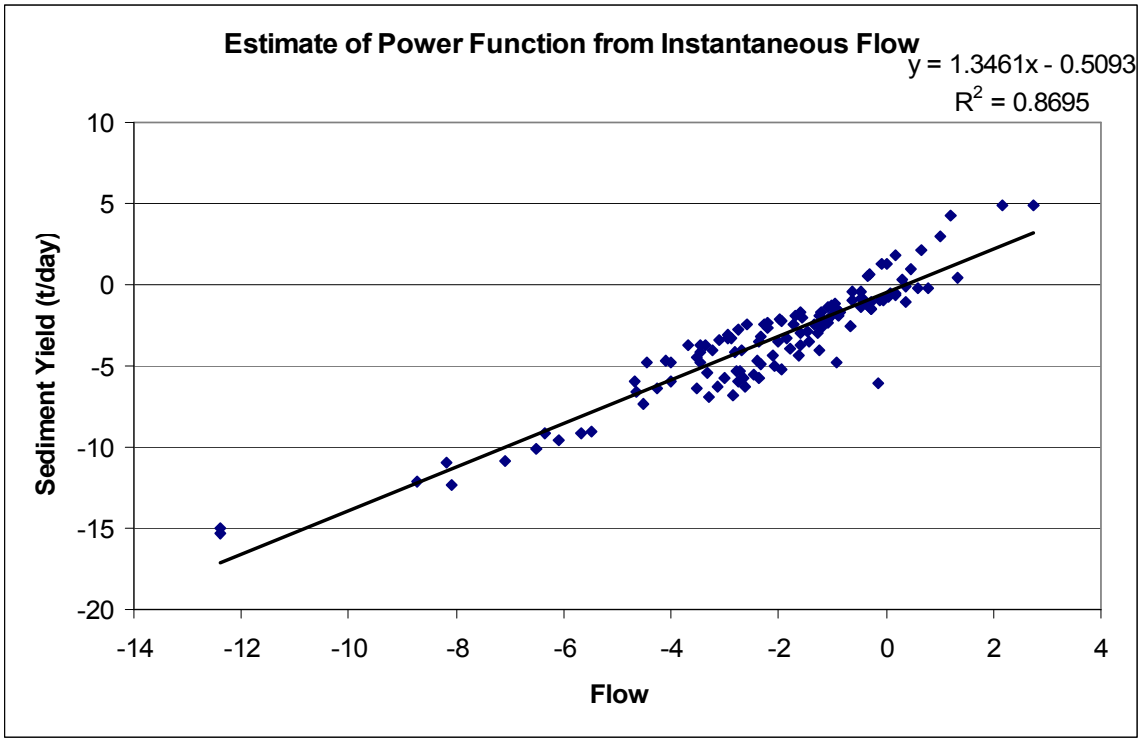
The watershed-size normalized data for the individual gages in the EDU were calculated and compared to a pooled data set including all of the gages. The results of this analysis are displayed in the following figure and table:



Gage	gage	area (mi^2)	normal Nash-Sutcliffe	lognormal Nash-Sutcliffe
Platte River	06820500	1760	80%	99%
Nodaway River	06817700	1380	90%	96%
Squaw Creek	06815575	62.7	86%	95%
102 River	06819500	515	99%	96%

This demonstrates the pooled data set can confidently be used as a surrogate for the EDU analyses.

The next step is to calculate pollutant-discharge relationships for the EDU; these are log transformed data for the yield (tons/mi^2/day) and the instantaneous flow (cfs/mi^2.) The following graph shows the EDU relationship:



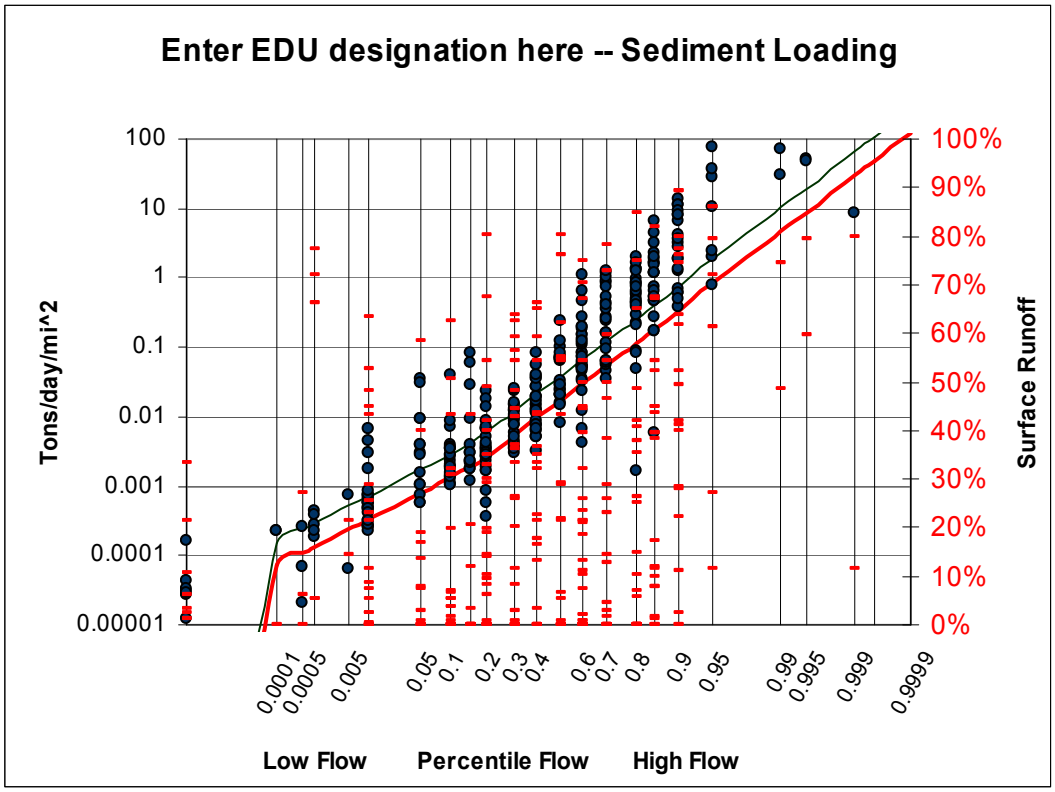
Further statistical analyses on this relationship are included in the following Table:

m	1.34608498	b	-0.509320019
Standard Error (m)	0.04721684	Standard Error (b)	0.152201589
r^2	0.86948229	Standard Error (y)	1.269553159
F	812.739077	DF	122
SSreg	1309.94458	SSres	196.6353573

The standard error of y was used to estimate the 25 percentile level for the TMDL line. This was done by adjusting the intercept (b) by subtracting the product of the one-sided Z_{75} statistic times the standard error of (y). The resulting TMDL Equation is the following:

*Sediment yield (t/day/mi^2) = exp (1.34608498 * ln (flow) - 1.36627)*

A resulting pooled TMDL of all data in the watershed is shown in the following graph:



To apply this process to a specific watershed would entail using the individual watershed data compared to the above TMDL curve that has been multiplied by the watershed area. Data from the impaired segment is then plotted as a load (tons/day) for the y-axis and as the percentile of flow for the EDU on the day the sample was taken for the x-axis.

Appendix D

Ecological Drainage Unit data used in TMDL development

Site	Date	Total Suspended Solids (mg/L)	Flow (cfs)
5495000	10/3/1989	16	60
5495000	3/6/1990	38	943
5495000	4/2/1990	52	4510
5495000	11/18/1992	55	281
5495000	1/6/1993	202	2640
5495000	3/24/1993	2010	3270
5495000	5/19/1993	7.5	142
5495000	7/20/1993	25	671
5495000	9/28/1993	152	930
5495000	11/2/1993	10	75
5495000	1/25/1994	64	1450
5495000	6/6/1994	100	107
5495000	8/3/1994	56	18
5495000	11/1/1994	68	60
5495000	1/3/1995	8	267
5495000	6/13/1995	60	659

Site	Date	Total Suspended Solids (mg/L)	Flow (cfs)
5495000	11/20/1995	14	31
5495000	2/6/1996	7	77
5495000	6/4/1996	120	655
5495000	8/19/1996	1400	4460
5495000	11/12/1996	10	16
5495000	1/7/1997	2	25
5495000	6/18/1997	890	1020
5495000	11/13/1997	14	5.7
5495000	11/13/1997	14	35
5495000	1/22/1998	19	45
5495000	5/6/1998	31	334
5495000	6/2/1998	0.5	213
5495000	8/5/1998	17	34
5495000	11/17/1998	32	284
5495000	11/17/1998	33	217
5495000	1/20/1999	13	305
5495000	5/19/1999	262	802
5495000	6/28/1999	78	55
5495000	8/9/1999	52	8.4
5495000	11/23/1999	9	7.3
5495000	11/23/1999	7	9.5
5495000	11/23/1999	13	0.04
5495000	11/23/1999	11	11
5495000	1/19/2000	1	6.8
5495000	5/22/2000	5	6.4
5495000	5/22/2000	5	0.24
5495000	5/23/2000	20	6.9
5495000	5/23/2000	55	85
5495000	7/11/2000	21	35
5495000	11/27/2000	5	12
5495000	11/28/2000	5	10
5495000	11/28/2000	22	0.32
5495000	11/28/2000	5	48
5495000	1/8/2001	5	4.3
5495000	5/15/2001	27	57
5495000	5/16/2001	638	1180
5495000	5/16/2001	262	646
5496000	5/17/2001	303	2150
5496000	7/24/2001	19	13
5496000	10/15/2001	13	132
5496000	11/13/2001	5	23
5496000	11/13/2001	24	0.96
5497150	11/14/2001	5	12
5497150	11/14/2001	20	31
5497150	12/6/2001	5	14
5497150	1/14/2002	5	23
5497150	1/14/2002	16	0.1
5500000	1/15/2002	5	13
5500000	1/15/2002	5	62

Site	Date	Total Suspended Solids (mg/L)	Flow (cfs)
5500000	2/11/2002	10	101
5500000	3/11/2002	788	374
5500000	3/11/2002	52	1
5500000	3/12/2002	260	449
5500000	3/12/2002	38	451
5500000	4/3/2002	12	51
5500000	5/14/2002	810	2020
5500000	5/14/2002	316	15300
5500000	5/14/2002	197	1090
5500000	5/15/2002	162	2200
5500000	6/3/2002	42	181
5500000	7/9/2002	84	120
5500000	7/9/2002	56	24
5500000	7/9/2002	45	7
5500000	7/10/2002	42	36
5500000	8/14/2002	5	4
5500000	9/3/2002	20	5.5
5500000	9/3/2002	15	0.12
5500000	9/4/2002	11	5.8
5500000	9/4/2002	19	12
5500000	10/8/2002	5	4
5500000	11/4/2002	33	7.5
5500000	11/4/2002	54	0.18
5500000	11/5/2002	13	4.5
5500000	11/5/2002	11	21
5500000	12/18/2002	5	7.7
5500000	1/6/2003	5	3.8
5500000	1/7/2003	5	6.9
5500000	1/7/2003	5	42
5500000	2/20/2003	5	65
5500000	3/4/2003	5	15
5500000	3/4/2003	5	18
5500000	3/4/2003	36	0.12
5500000	3/4/2003	12	117
5500000	4/8/2003	13	44
5500000	5/20/2003	49	57
5500000	5/20/2003	17	85
5500000	5/20/2003	39	6.1
5500000	5/20/2003	41	265
5500000	6/17/2003	5	42
5500000	7/21/2003	25	37
5500000	7/21/2003	27	4.2
5500000	7/22/2003	16	29
5500000	7/22/2003	25	34
5500000	8/6/2003	27	35
5500000	9/2/2003	138	81
5500000	9/2/2003	168	99
5500000	9/3/2003	34	226
5500000	9/3/2003	42	641

Site	Date	Total Suspended Solids (mg/L)	Flow (cfs)
5500000	10/21/2003	5	44
5500000	11/3/2003	26	173
5500000	11/3/2003	49	67
5500000	11/4/2003	13	34
5500000	11/13/2003	17	44
5500000	12/16/2003	171	2000
5500000	1/5/2004	19	68
5500000	1/6/2004	17	122
5500000	1/6/2004	20	6.8
5500000	1/13/2004	24	222
5500000	2/3/2004	5	50
5500000	3/1/2004	17	219
5500000	3/2/2004	18	161
5500000	3/2/2004	18	12
5500000	3/3/2004	75	137
5500000	4/5/2004	10	124
5500000	5/3/2004	52	650
5500000	5/18/2004	23	36
5500000	5/18/2004	14	60
5500000	5/18/2004	24	5.1
5500000	6/21/2004	40	75
5500000	7/20/2004	32	49
5500000	7/21/2004	36	23
5500000	7/21/2004	22	36
5500000	7/21/2004	56	2
5500000	8/17/2004	21	15
5500000	9/13/2004	17	55
5500000	9/13/2004	11	16
5500000	9/14/2004	5	42
5500000	9/14/2004	5	23
5500000	10/13/2004	328	1480
5500000	11/1/2004	354	794
5500000	11/2/2004	340	4930
5500000	11/2/2004	190	18900
5500000	12/15/2004	19	206
5500000	1/4/2005	1020	1010
5500000	1/5/2005	760	5850
5500000	1/5/2005	483	30800
5500000	2/1/2005	5	144
5500000	3/8/2005	13	87
5500000	3/8/2005	5	133
5500000	3/9/2005	5	160
5500000	4/4/2005	5	120
5500000	5/2/2005	16	87
5500000	5/2/2005	20	114
5500000	5/3/2005	24	192
5500000	6/7/2005	252	725
5500000	7/26/2005	25	9.2
5500000	7/26/2005	5	2.5

Site	Date	Total Suspended Solids (mg/L)	Flow (cfs)
5500000	7/26/2005	13	7.4
5500000	8/2/2005	43	5.8
5500000	9/7/2005	37	2.7
5500000	9/7/2005	5	2.1
5500000	9/7/2005	5	7.9
5500000	10/12/2005	5	16
5500000	11/7/2005	15	1.6
5500000	11/8/2005	15	2.4
5500000	11/8/2005	34	127
5500000	12/19/2005	5	12
5500000	1/10/2006	5	7
5500000	1/10/2006	5	7.7
5500000	1/10/2006	5	55
5500000	2/7/2006	42	25
5500000	3/7/2006	5	28
5500000	3/7/2006	5	8.1
5500000	3/7/2006	5	31
5500000	4/11/2006	34	105
5500000	5/15/2006	5	27
5500000	5/15/2006	13	30
5500000	5/16/2006	21	63
5500000	6/14/2006	17	28
5500000	7/20/2006	21	19
5500000	7/25/2006	23	7.8
5500000	7/26/2006	16	3.4
5500000	8/15/2006	13	156
5500000	9/6/2006	48	3
5500000	9/6/2006	5	15
5500000	9/6/2006	17	3.7
5500000	10/10/2006	5	0.49
5500000	11/6/2006	5	4.7
5500000	11/7/2006	5	3.1
5499900	11/8/2006	5	1.5
5499900	12/5/2006	48	83
5499900	1/3/2007	74	169
5499900	1/3/2007	87	269
5499900	1/8/2007	5	85
5499900	2/12/2007	5	27
5499900	2/12/2007	10	60
5499900	2/13/2007	5	34
5499900	3/6/2007	80	171
5499900	3/6/2007	92	305
5499900	3/12/2007	23	265
5499900	4/2/2007	165	433
5499900	4/2/2007	460	1490
5499900	4/24/2007	26	189
5499900	5/1/2007	100	225
5499900	5/1/2007	36	272
5499900	5/21/2007	32	59

Site	Date	Total Suspended Solids (mg/L)	Flow (cfs)
5499900	6/4/2007	23	151
5499900	6/5/2007	352	424
5499900	6/5/2007	254	368
5499900	7/9/2007	21	9.4
5508000	7/9/2007	23	11
5508000	7/9/2007	22	20
5508000	8/13/2007	18	4
5514500	9/5/2007	14	1.7
5514500	9/10/2007	33	83
5514500	9/10/2007	15	4.7
5514500	10/23/2007	50	63
5514500	11/5/2007	5	19
5514500	11/5/2007	5	0.97
5514500	11/7/2007	25	1.9
5514500	12/3/2007	5	0.94
5514500	1/7/2008	600	2180
5514500	1/8/2008	120	232
5514500	1/23/2008	22	47
5514500	2/13/2008	42	793
5514500	3/4/2008	660	6040
5514500	3/4/2008	1020	4030
5514500	3/26/2008	39	351
5514500	4/14/2008	100	559
5514500	5/8/2008	32	203
5514500	5/22/2008	22	269
5514500	6/2/2008	200	333
5514500	7/8/2008	752	356
5514500	7/8/2008	27	240
5514500	7/23/2008	412	2660
5514500	8/4/2008	40	329
5514500	9/3/2008	22	20
5514500	9/3/2008	82	142
5514500	9/3/2008	43	48
5514500	10/21/2008	5	62
5514500	10/21/2008	7.5	26
5514500	10/21/2008	7.5	58
5514500	10/21/2008	19	138
5514500	10/22/2008	7.5	300
5514500	11/13/2008	24	98
5514500	12/8/2008	7.5	52
5514500	1/5/2009	42	144
5514500	1/5/2009	7.5	610
5514500	1/6/2009	29	473
5514500	1/6/2009	28	190
5514500	1/6/2009	19	240
5514500	2/2/2009	7.5	73
5514500	3/16/2009	144	314
5514500	3/16/2009	372	448
5514500	3/16/2009	38	277

Site	Date	Total Suspended Solids (mg/L)	Flow (cfs)
5514500	3/17/2009	182	416
5514500	3/17/2009	148	375
5514500	4/1/2009	262	627
5514500	5/4/2009	242	332
5514500	5/4/2009	212	429
5514500	5/4/2009	312	551
5514500	5/4/2009	133	563
5514500	5/5/2009	53	549
5514500	6/2/2009	19	172
5514500	7/28/2009	40	39
5514500	7/28/2009	42	29
5514500	7/28/2009	36	48
5514500	7/29/2009	29	34
5514500	7/29/2009	950	4760
5514500	8/18/2009	436	1520
5514500	9/1/2009	36	88
5514500	9/2/2009	27	8.3